Knock Characteristics by Motor Method

Scope

This method covers the knock characteristics of motor gasolines in terms of ASTM motor octane number.

Summary

The ASTM motor octane number of fuel is determined by adjusting the compression ratio for the sample so that the knock intensity is equivalent to that of a standardization fuel of similar octane and then consulting a table to obtain the actual octane number based on the compression ratio.

Comments

All samples shall be cooled to a temperature between 35°F and 50°F before the container is opened and the sample is introduced into the appropriate carburetor bowl.

Reagents

A. ASTM isooctane.

B. ASTM 80 octane blend.

C. ASTM N-Heptane primary reference fuel.

D. ASTM Reference Fuel toluene.

Apparatus and Materials

A. Bottles for reference fuel mixtures.

B. Research testing unit consisting of a single cylinder engine of continuously variable compression ratio, with suitable loading and accessory equipment and instruments.

Procedure

A. Fill the air humidity control tower with ice to a depth of at least 36 inches.

B. Set up the carburetor cooling system: attach the inlet hose to the pump and place the pump in a five gallon pail containing enough water to cover the pump. Plug in the pump and briefly pump water through the system and down the drain. Place the outlet hose into the pail and fill the pail with ice to enable ice water to circulate through the system.

C. Find an empty five gallon metal can in the flammable storage room and position it under the carburetor drain hoses. Place the hose ends in the opening in the can.

D. Bring the level of water in the engine heat exchanger reservoir so it is just visible in the bottom of the sight glass by adding distilled water through the top opening.

E. Turn on the cooling water to the heat exchanger.

F. Turn on the circuit breaker for the engine at the panel on the south wall of the engine room.

G. Before starting the engine:

1. Check oil level - it should be more than half full on the sight glass on the right side of the engine.

2. Check to make sure the oil temperature is 135 ± 15^{o}.

3. Check to make sure the fly wheel marks are set at top dead center.

4. Uncover the opening on the top of the air humidity control tower.

5. Fill the right carburetor bowl with warm-up fuel.

H. Start the engine with the four switches at the bottom center of the engine panel. To start, turn the start knob as far right as it goes and watch the oil pressure gauge. When the oil pressure reaches 30, release the start switch and turn on the ignition, air heater, and mixture heater switches.

I. Turn the carburetor feed knob to feed fuel to the engine from the carburetor bowl

containing the warm up fuel.

J. Watch the oil pressure while the engine is running. If it drops to lower than 24 psi, turn the fuel selector to an off position and stop the engine. Correct the cause of the trouble before trying to restart the engine.

K. The heater switch on the engine panel should be in the mixture heater position. The temperature control should be set so that the thermometer reads not less than 275° when the engine is running.

L. Allow the engine to warm up until the air heater temperature reaches the required range (95-105°) and stabilizes, and the mixture heater temperature stabilizes at not less than 275°.

M. While the engine is warming up, knock rating standards can be prepared as follows: (Make a quantity of each that will be adequate for the number of samples to be tested).

83 octane	15% of 100% isooctane 85% of 80 blend
85 octane	25% of 100% isooctane 75% of 80 blend
86 octane	30% of 100% isooctane 70% of 80 blend
88 octane	40% of 100% isooctane 60% of 80 blend

N. Before rating samples, the engine must be qualified on a toluene standardization fuel. Prepare this fuel by pipetting 105 ml of ASTM N-Heptane primary reference fuel and 25 ml of ASTM isooctane into a 500 ml volumetric flask and bringing to volume with ASTM reference fuel toluene. Mix well. This blend should rate at 85.3 ± .3 motor octane units.

O. Fill the left two carburetor bowls with 83 and 85 octane reference fuels. Place the toluene standardization fuel in the third carburetor bowl.

P. Read the barometer and consult the chart for the digital counter correction. Add the digital counter correction to the value of the bottom number on the digital counter and set the top number on the digital counter to this sum.

Q. Turn the selector valve to operate on the 85 octane reference fuel and set the

digital counter bottom number to 648.

R. Adjust the fuel/air ratio to give the maximum reading on the knockmeter. The fuel/air ratio must be between 0.7 and 1.7.

S. When the meter has reached equilibrium, use the meter adjust knob to bring the reading to 50 ± 2. Record the reading after equilibrium is reached.

T. Turn the selector valve to operate on the toluene standardization fuel and adjust the fuel/air ratio to give the maximum reading on the knockmeter.

U. When the meter has reached equilibrium, adjust the cylinder height to bring the meter reading to the same point that was set for the 85 octane reference fuel. Record the bottom number on the digital counter and consult the chart for the corresponding octane.

V. Repeat steps Q-U at least twice more. The average of the octane ratings for the toluene standardization fuel should be 85.3 ± 3.

W. If the toluene standardization fuel does not rate within proper limits, adjustment of the mixture heater temperature can be done to attempt to bring the rating within proper limits. In no case should the mixture heater temperature be allowed to drop below 275°. After the temperature has been adjusted, repeat steps Q-U. If the engine still does not rate, the problem must be found and corrected before testing samples.

X. Use the following guidelines for rating samples:

Unleaded and Regular samples should compare with 83 or 85 octane reference fuels.

Alcohol blends should compare with 85 or 86 octane reference fuels.

Premium samples should compare with 86 or 88 octane reference fuels.

Y. Fill the right two carburetor bowls with the first two samples. Manipulate the drain valves to remove all bubbles from the line to the carburetor.

Z. Turn the selector valve to operate on the proper octane reference fuel and set the

digital counter bottom number to correspond to the counter setting from the chart.

AA. Repeat steps R and S from above.

BB. Turn the selector vale to operate on the first sample and adjust the fuel/air ratio to give the maximum reading on the knockmeter.

CC. When the meter has reached equilibrium, adjust the cylinder height to bring the meter reading to the same point that was set for the octane reference fuel. Record the bottom number on the digital counter and consult the chart for the corresponding octane. If the octane result is closer to the octane number of the next higher or lower octane reference fuel, the sample should be tested against the next higher or lower octane reference fuel.

DD. Continue rating samples as above, checking the octane reference fuel after every five samples are tested or more frequently if necessary.

EE. After all the samples have been tested, turn the fuel selector valve to an intermediate position to shut off the fuel supply to the engine. When the knockmeter needle starts dropping, allow it to drop about 20 units and then turn off the mixture heater switch, air heater switch and ignition switch in that order. Then turn off the start switch and hold in the stop position until the engine comes to a complete stop.

FF. Turn off the detonation meter switches.

GG. Rotate the flywheel to top dead center on the compression stroke to protect the valves and cylinder parts from corrosion.

HH. Drain all carburetor bowls and remove the waste collection can.

II. Disconnect the carburetor cooling system and drain the lines.

JJ. Turn off the cooling water to the engine.

KK. Turn off the engine circuit breaker in the knock room.